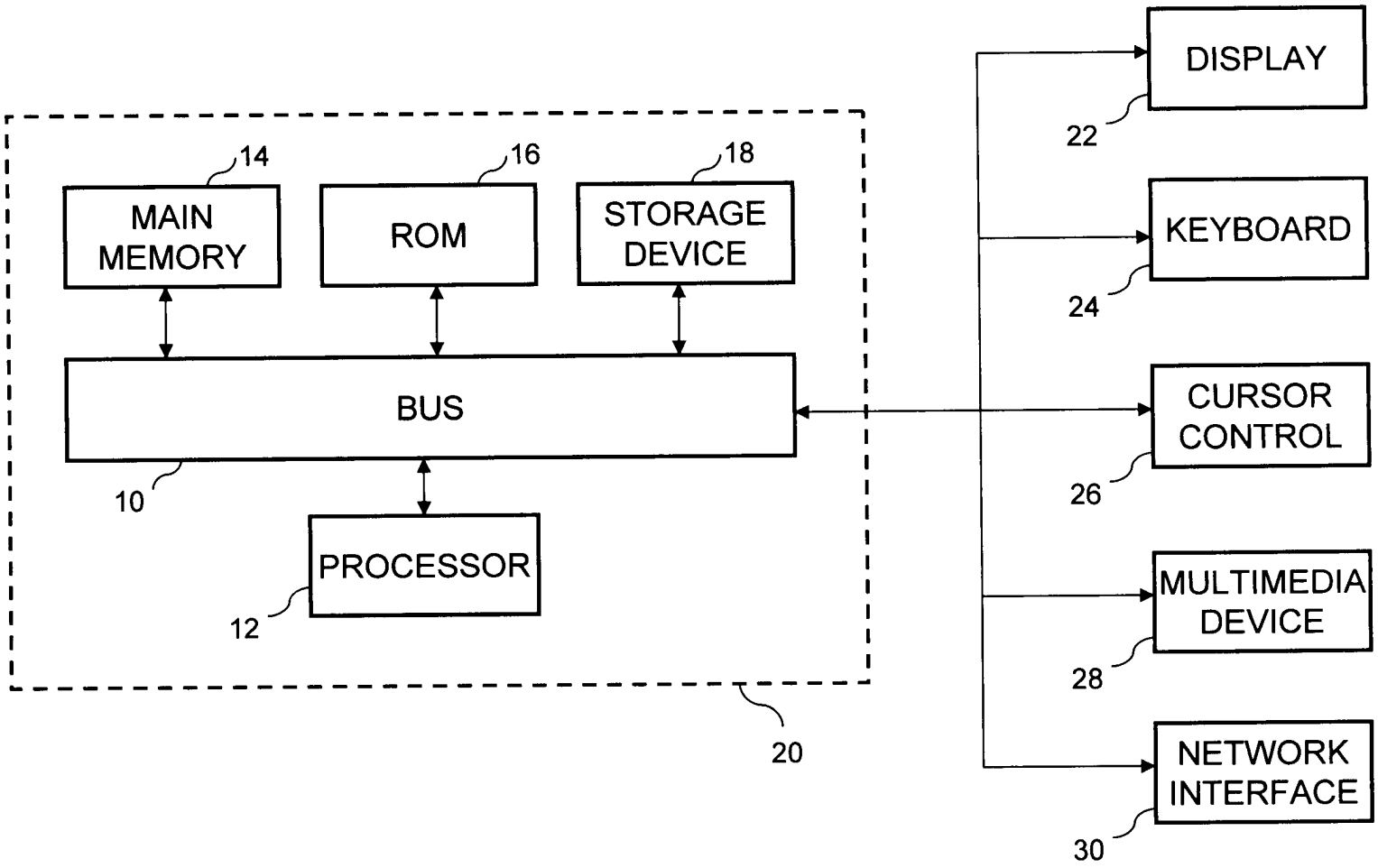

MAIN MEMORY
14
ROM
16
STORAGE DEVICE
18
BUS
10
PROCESSOR
12
20
DISPLAY
22
KEYBOARD
24
CURSOR CONTROL
26
MULTIMEDIA DEVICE
28
NETWORK INTERFACE
30

FIG. 1

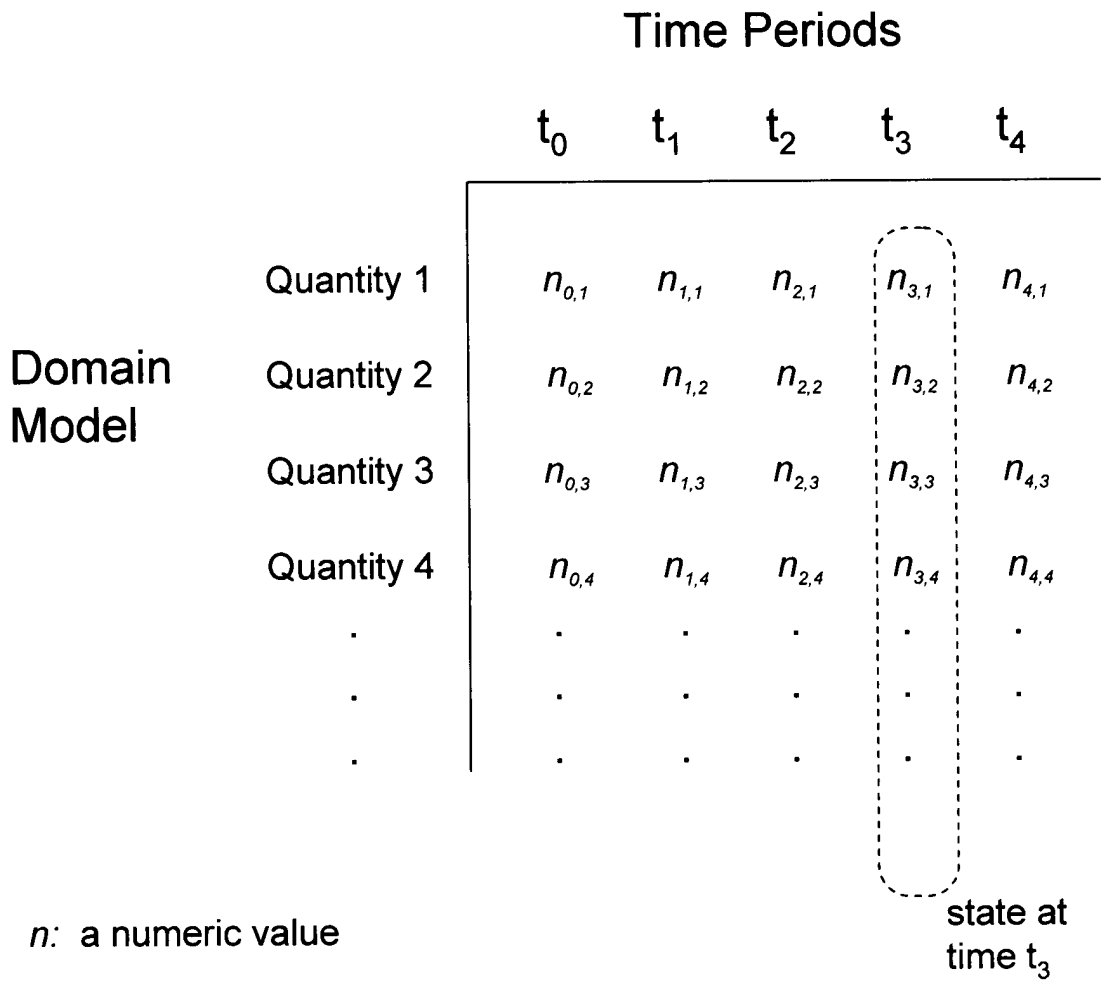

Time Periods
t_0 t_1 t_2 t_3 t_4
Domain Model
Quantity 1
Quantity 2
Quantity 3
Quantity 4
$n_{0,1}$ $n_{1,1}$ $n_{2,1}$ $n_{3,1}$ $n_{4,1}$
$n_{0,2}$ $n_{1,2}$ $n_{2,2}$ $n_{3,2}$ $n_{4,2}$
$n_{0,3}$ $n_{1,3}$ $n_{2,3}$ $n_{3,3}$ $n_{4,3}$
$n_{0,4}$ $n_{1,4}$ $n_{2,4}$ $n_{3,4}$ $n_{4,4}$
state at time t_3
n: a numeric value

FIG. 2

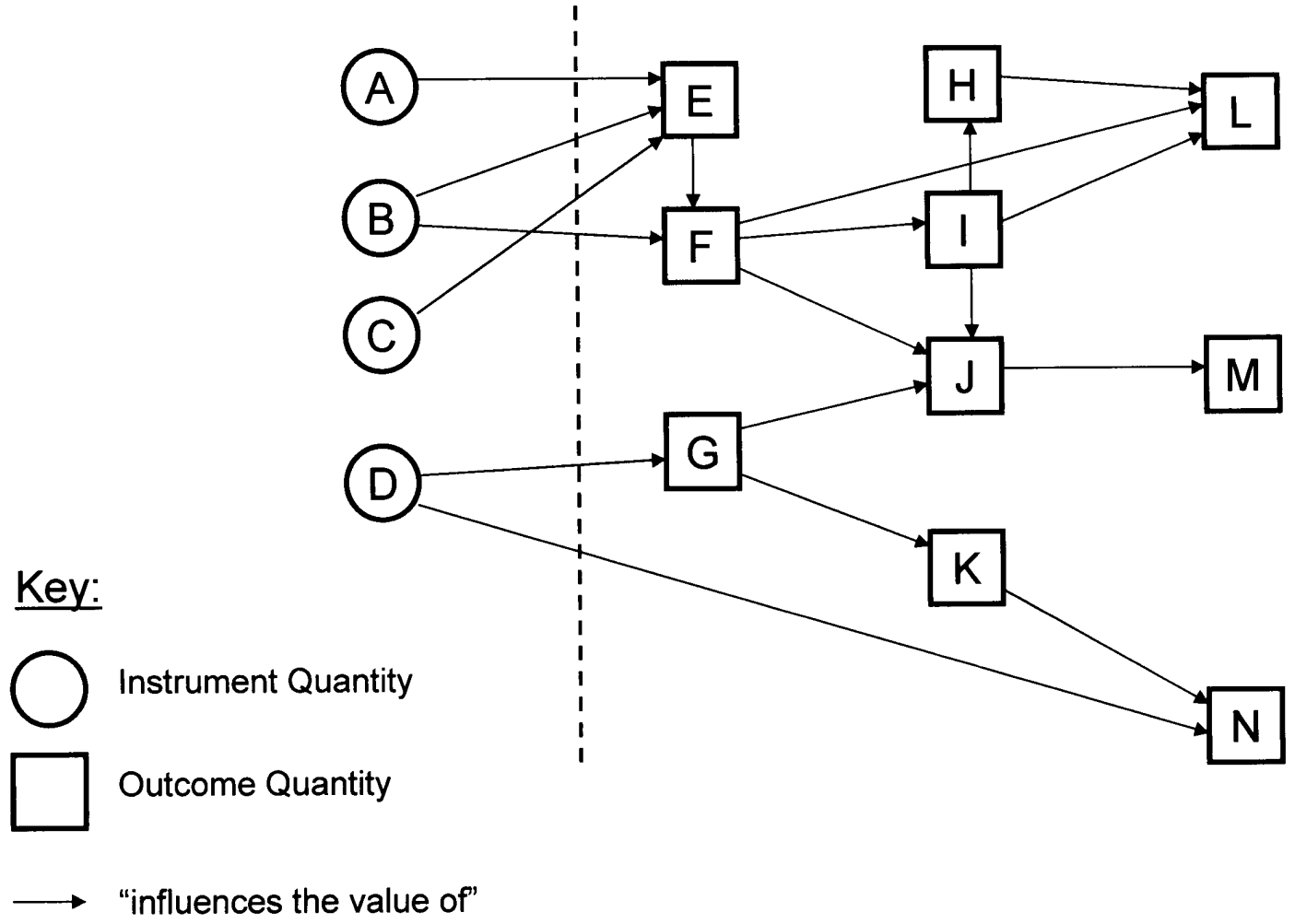

A
B
C
D
E
F
G
H
I
J
K
L
M
N
Key:
Instrument Quantity
Outcome Quantity
"influences the value of"

FIG. 3

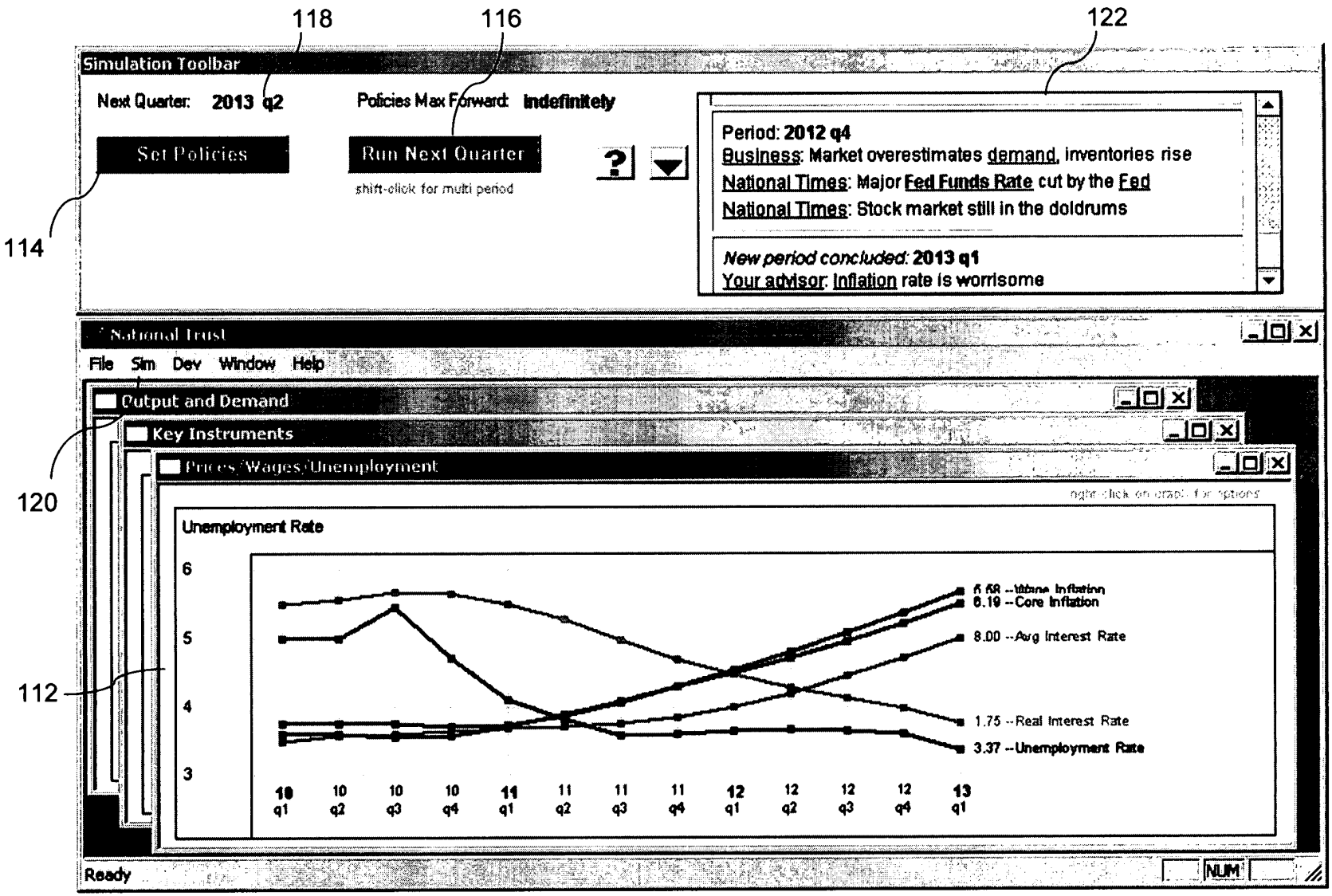

118
116
122
Simulation Toolbar
Next Quarter: 2013 q2
Policies Max Forward: indefinitely
Set Policies
Run Next Quarter
shift-click for multi period
Period: 2012 q4
Business: Market overestimates demand, inventories rise
National Times: Major Fed Funds Rate cut by the Fed
National Times: Stock market still in the doldrums
New period concluded: 2013 q1
Your advisor: Inflation rate is worrisome
114
National Trust
File Sim Dev Window Help
120
Output and Demand
Key Instruments
Prices/Wages/Unemployment
Unemployment Rate
112
6
5
4
3
8.00 --Avg Interest Rate
1.75 --Real Interest Rate
3.37 --Unemployment Rate
10 q1
10 q2
10 q3
10 q4
11 q1
11 q2
11 q3
11 q4
12 q1
12 q2
12 q3
12 q4
13 q1
Ready
NUM

FIG. 4

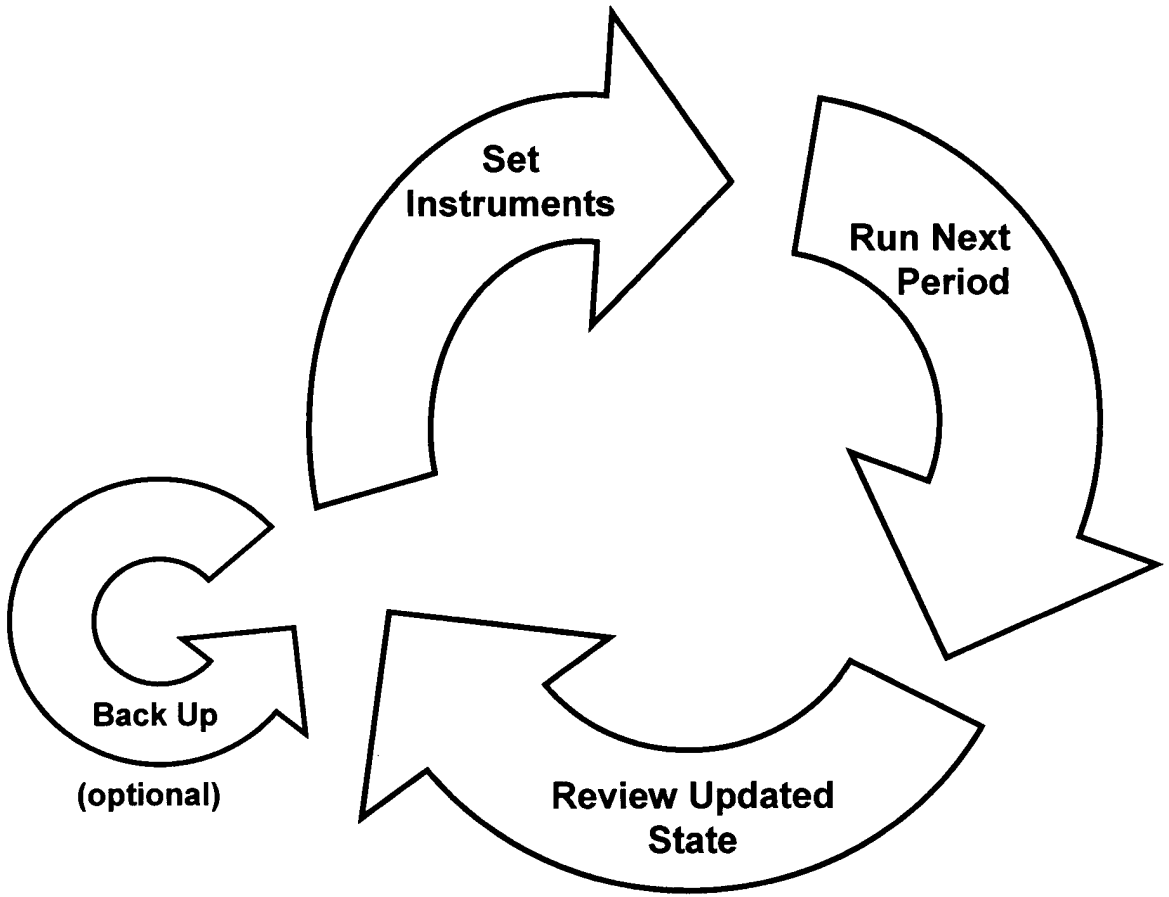

Set
Instruments
Run Next
Period
Back Up
(optional)
Review Updated
State

FIG. 5

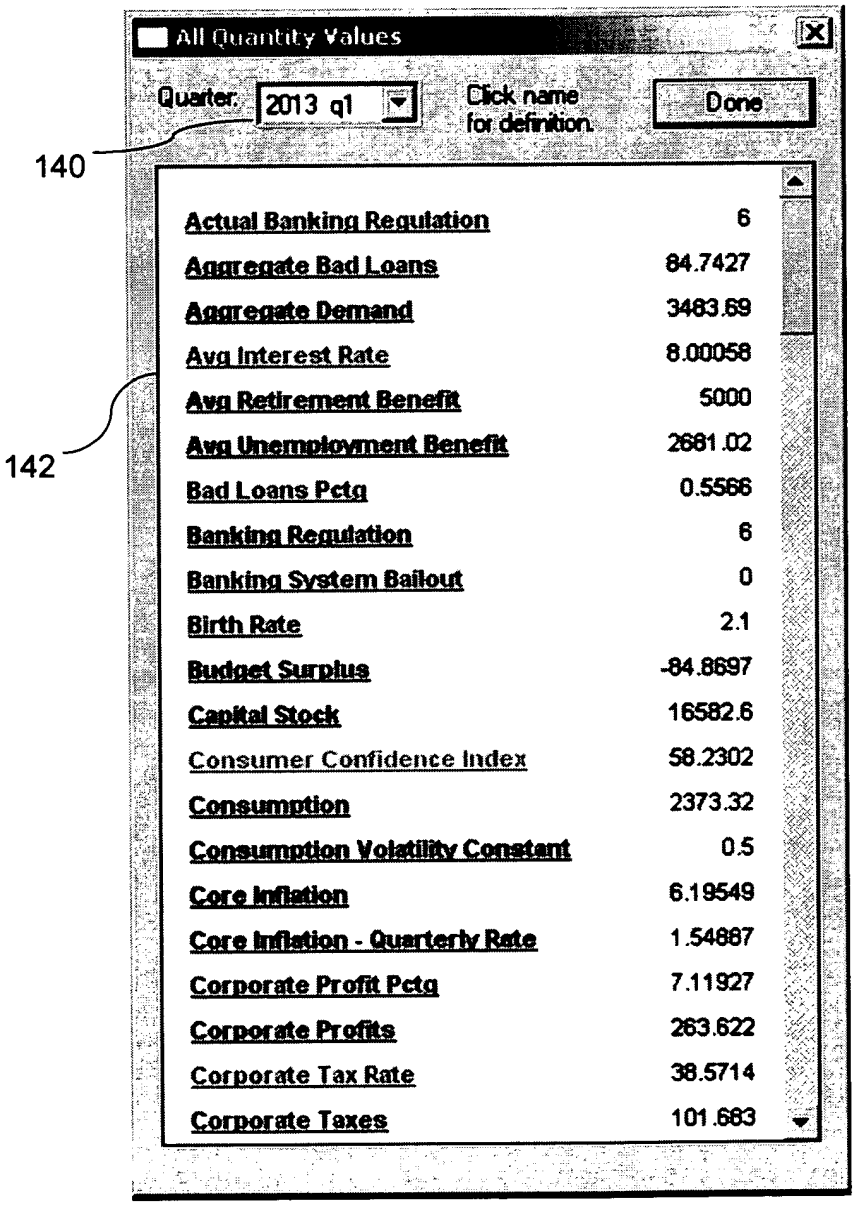

All Quantity Values
Quarter:
2013 q1
Click name for definition.
Done
140
142
Actual Banking Regulation 6
Aggregate Bad Loans 84.7427
Aggregate Demand 3483.69
Avg Interest Rate 8.00058
Avg Retirement Benefit 5000
Avg Unemployment Benefit 2681.02
Bad Loans Pctg 0.5566
Banking Regulation 6
Banking System Bailout 0
Birth Rate 2.1
Budget Surplus -84.8697
Capital Stock 16582.6
Consumer Confidence Index 58.2302
Consumption 2373.32
Consumption Volatility Constant 0.5
Core Inflation 6.19549
Core Inflation - Quarterly Rate 1.54887
Corporate Profit Pctg 7.11927
Corporate Profits 263.622
Corporate Tax Rate 38.5714
Corporate Taxes 101.683

FIG. 6

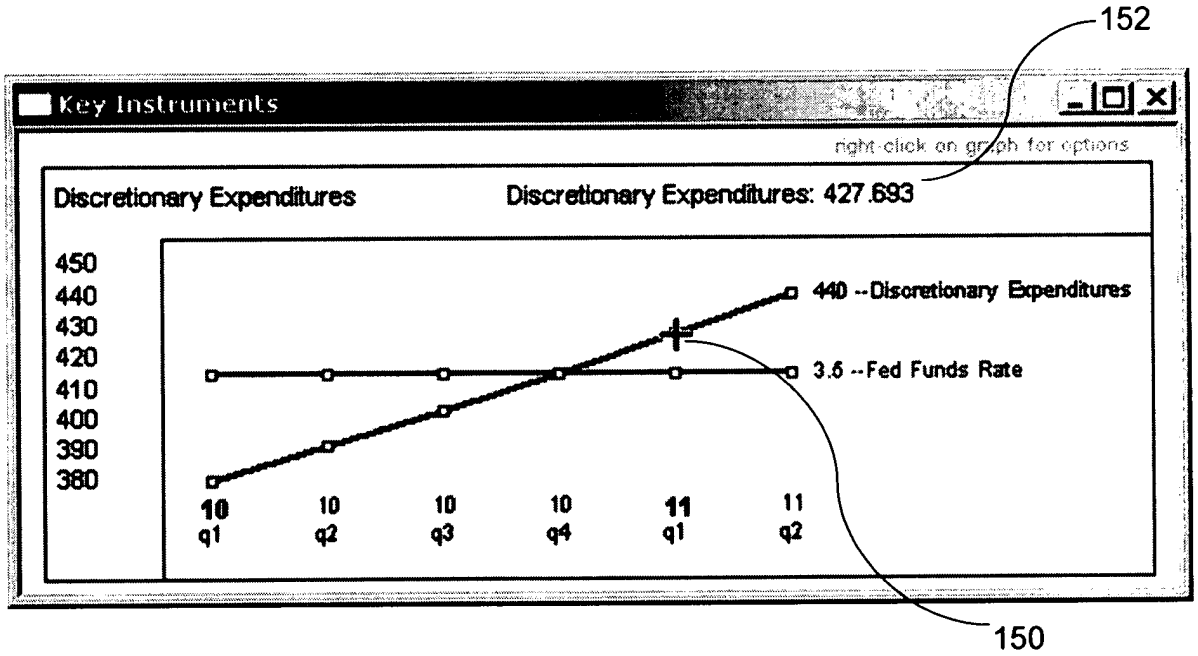

152
Key Instruments
right-click on graph for options
Discretionary Expenditures
Discretionary Expenditures: 427.693
450
440
430
420
410
400
390
380
440 --Discretionary Expenditures
3.6 --Fed Funds Rate
10 q1
10 q2
10 q3
10 q4
11 q1
11 q2
150

FIG. 7

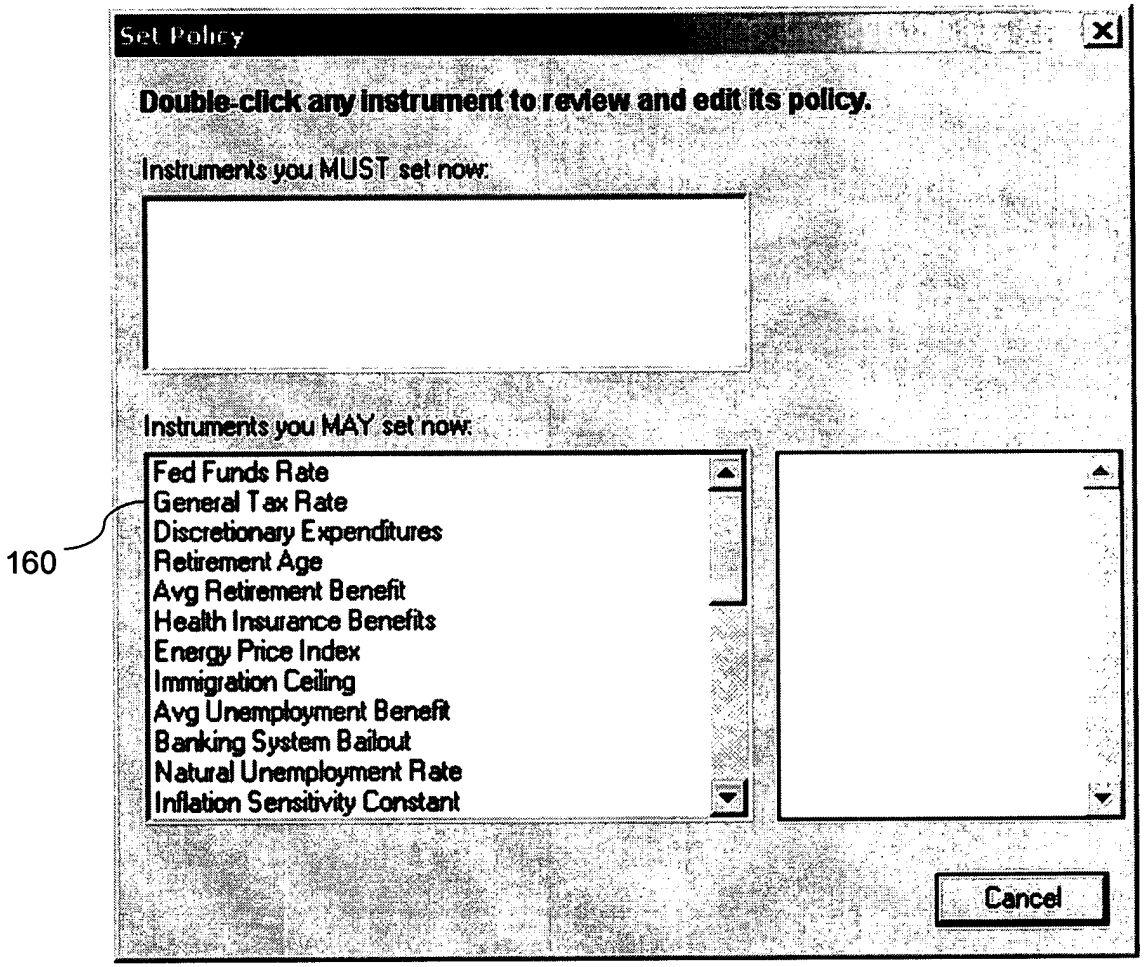

Set Policy
Double-click any instrument to review and edit its policy.
Instruments you MUST set now:
Instruments you MAY set now:
Fed Funds Rate
General Tax Rate
Discretionary Expenditures
Retirement Age
Avg Retirement Benefit
Health Insurance Benefits
Energy Price Index
Immigration Ceiling
Avg Unemployment Benefit
Banking System Bailout
Natural Unemployment Rate
Inflation Sensitivity Constant
Cancel
160

FIG. 8

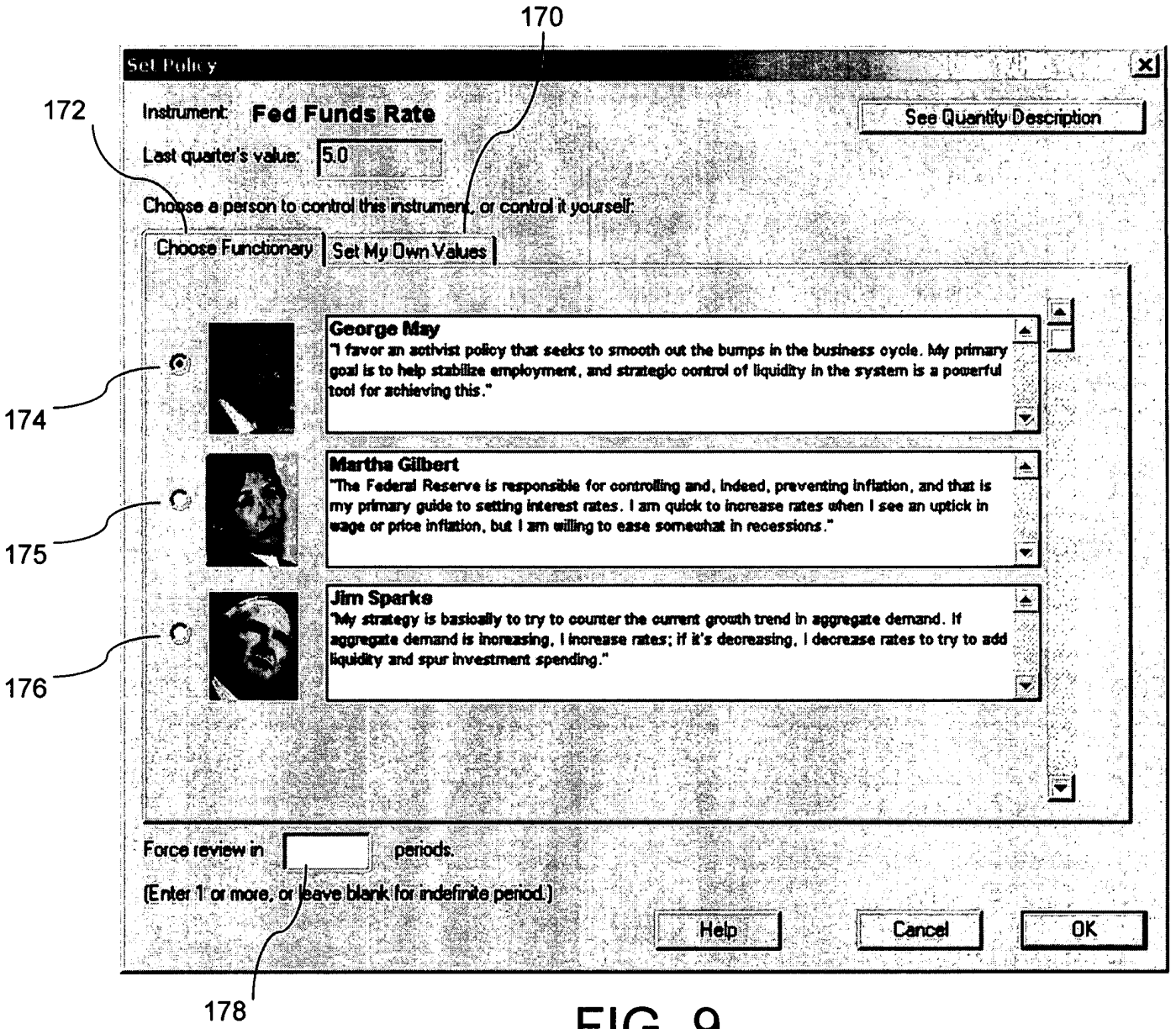

170
Set Policy
172
Instrument: Fed Funds Rate
See Quantity Description
Last quarter's value: 5.0
Choose a person to control this instrument, or control it yourself:
Choose Functionary
Set My Own Values
George May
"I favor an activist policy that seeks to smooth out the bumps in the business cycle. My primary goal is to help stabilize employment, and strategic control of liquidity in the system is a powerful tool for achieving this."
174
Martha Gilbert
"The Federal Reserve is responsible for controlling and, indeed, preventing inflation, and that is my primary guide to setting interest rates. I am quick to increase rates when I see an uptick in wage or price inflation, but I am willing to ease somewhat in recessions."
175
Jim Sparks
"My strategy is basically to try to counter the current growth trend in aggregate demand. If aggregate demand is increasing, I increase rates; if it's decreasing, I decrease rates to try to add liquidity and spur investment spending."
176
Force review in periods.
(Enter 1 or more, or leave blank for indefinite period.)
178
Help
Cancel
OK

FIG. 9

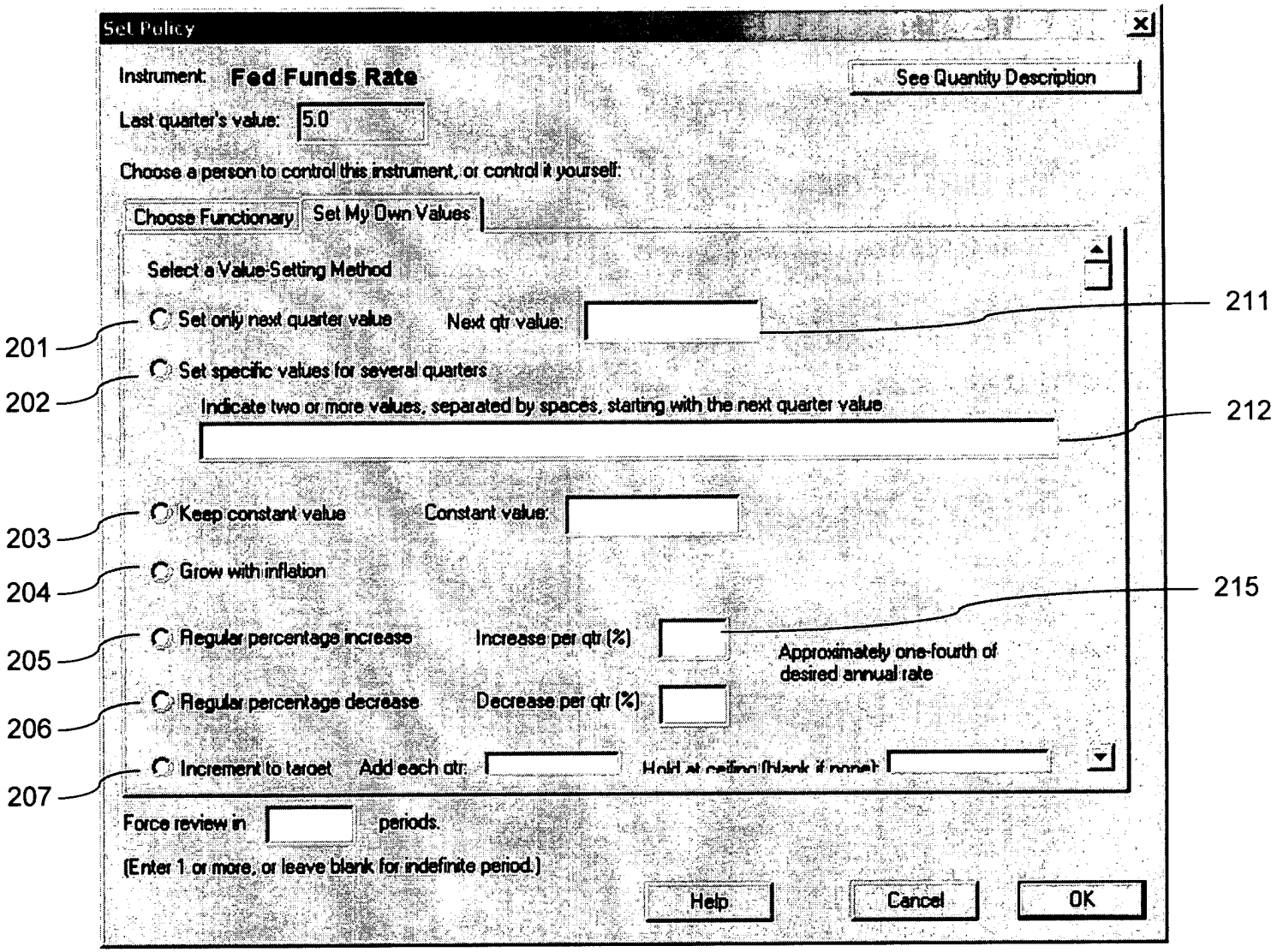

Set Policy
Instrument: Fed Funds Rate
See Quantity Description
Last quarter's value: 5.0
Choose a person to control this instrument, or control it yourself:
Choose Functionary
Set My Own Values
Select a Value-Setting Method
Set only next quarter value
Next qtr value:
Set specific values for several quarters
Indicate two or more values, separated by spaces, starting with the next quarter value
Keep constant value
Constant value:
Grow with inflation
Regular percentage increase
Increase per qtr (%)
Approximately one-fourth of desired annual rate
Regular percentage decrease
Decrease per qtr (%)
Increment to target
Add each qtr:
Force review in
periods.
(Enter 1 or more, or leave blank for indefinite period.)
Help
Cancel
OK
201
202
203
204
205
206
207
211
212
215

FIG. 10

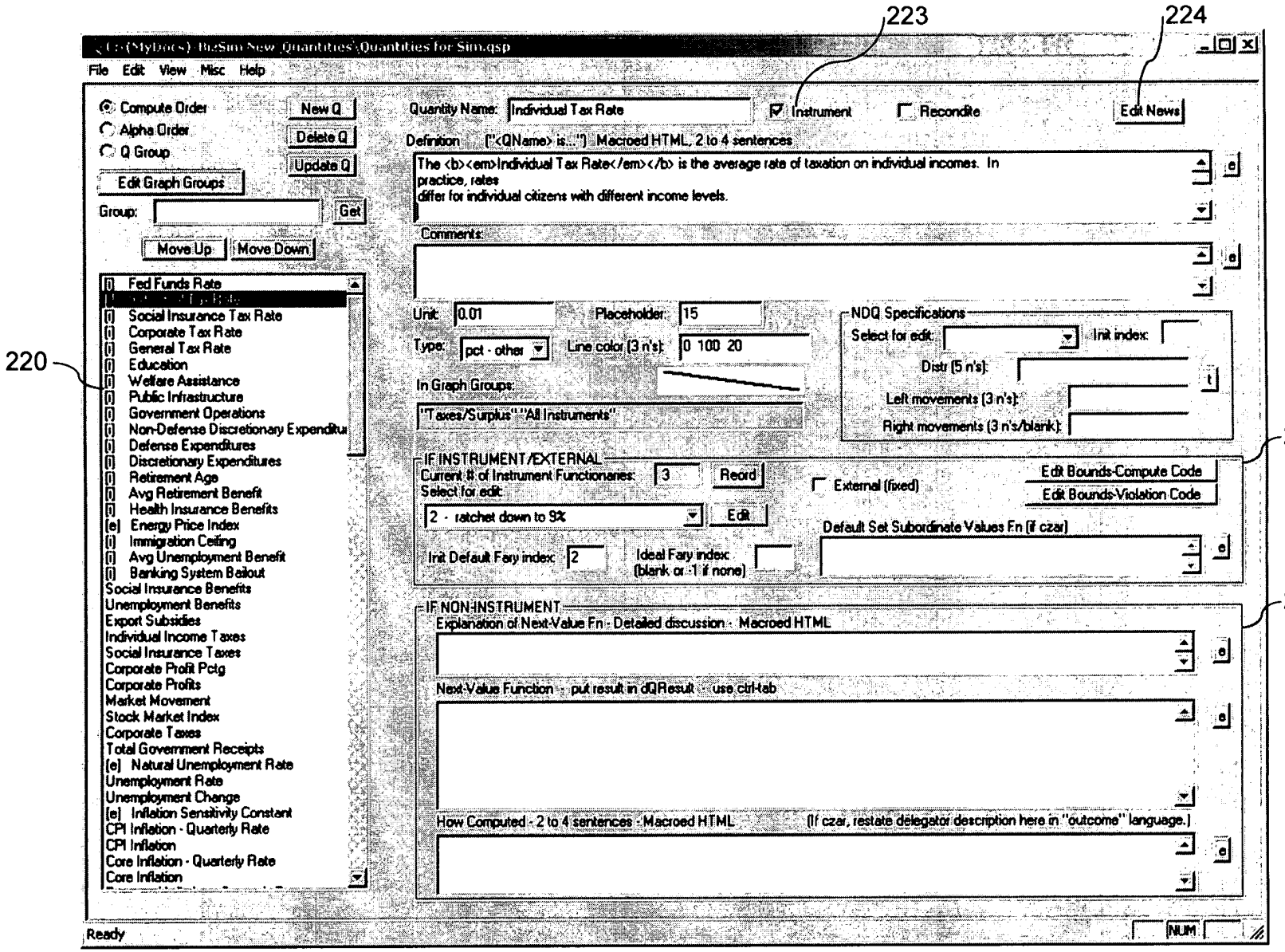

223
224
220
221
222
File Edit View Misc Help
Compute Order
Alpha Order
Q Group
New Q
Delete Q
Update Q
Edit Graph Groups
Group:
Get
Move Up
Move Down
Fed Funds Rate
Social Insurance Tax Rate
Corporate Tax Rate
General Tax Rate
Education
Welfare Assistance
Public Infrastructure
Government Operations
Non-Defense Discretionary Expenditu
Defense Expenditures
Discretionary Expenditures
Retirement Age
Avg Retirement Benefit
Health Insurance Benefits
Energy Price Index
Immigration Ceiling
Avg Unemployment Benefit
Banking System Bailout
Social Insurance Benefits
Unemployment Benefits
Export Subsidies
Individual Income Taxes
Social Insurance Taxes
Corporate Profit Pctg
Corporate Profits
Market Movement
Stock Market Index
Corporate Taxes
Total Government Receipts
Natural Unemployment Rate
Unemployment Rate
Unemployment Change
Inflation Sensitivity Constant
CPI Inflation - Quarterly Rate
CPI Inflation
Core Inflation - Quarterly Rate
Core Inflation
Quantity Name: Individual Tax Rate
Instrument
Recondite
Edit News
Definition ("<QName> is...") Macroed HTML, 2 to 4 sentences
The Individual Tax Rate is the average rate of taxation on individual incomes. In practice, rates
differ for individual citizens with different income levels.
Comments:
Unit: 0.01
Placeholder: 15
Type: pct - other
Line color (3 n's): 0 100 20
In Graph Groups:
"Taxes/Surplus" "All Instruments"
NDQ Specifications
Select for edit:
Init index:
Distr (5 n's):
Left movements (3 n's):
Right movements (3 n's/blank):
IF INSTRUMENT/EXTERNAL
Current # of Instrument Functionaries: 3
Reord
External (fixed)
Edit Bounds-Compute Code
Edit Bounds-Violation Code
Select for edit:
2 - ratchet down to 9%
Edit
Default Set Subordinate Values Fn (if czar)
Init Default Fary index: 2
Ideal Fary index (blank or -1 if none)
IF NON-INSTRUMENT
Explanation of Next-Value Fn - Detailed discussion - Macroed HTML
Next-Value Function - put result in dQResult - use ctrl-tab
How Computed - 2 to 4 sentences - Macroed HTML
(If czar, restate delegator description here in "outcome" language.)
Ready
NUM

FIG. 11

Field Name	Data Type	Description
Common fields		
sName	string	A unique identifier for the quantity. This is the name that the student sees, and is also the name used within algorithms to access the quantity values in a scenario. Quantity identifiers are case-insensitive, and any two sequences of whitespace characters are always considered equivalent.
bInstrument	boolean	If FALSE, indicates that the quantity is an outcome quantity. If TRUE, indicates that the instrument is either an instrument quantity or an external quantity (described later).
sDefinition	string	Provides a brief textual description of the quantity, available to the student. Format is HTML, so that text formatting and links to related information can be embedded. All quantities should observe a similar style and voice in this field.
sUnit	string	A standardized text description of what kind of number value the quantity holds. Examples include "1 kilogram", "percent", "years", or "$1 Billion".
dPlaceholder	floating point	The default initial value for the quantity, that is, for period 0.
sNewsFn	string	Optional. C code that can generate a qualitative description of a change in the state of the model (described later).
LineColor	integer	An RGB color value. This color is used as the line color whenever the quantity appears in any QuantitiesGroup window. It may also be used as the text color whenever the quantity name appears as a hyperlink anywhere in the learning environment.

FIG. 12A

Field Name	Data Type	Description
Outcome-specific fields		
sNextValueFn	string	C code that implements the outcome quantity's value-computation algorithm. Assumes the result will be placed in the predefined floating-point variable dQResult.
sNextValueDescr	string	Provides a brief textual description of the value-computation algorithm. Format is HTML, so that text formatting and links to related information can be embedded. All quantities should observe a similar style and voice in this field.
sExplainNVFn	string	Optional. Provides a longer, more detailed textual description of the value-computation algorithm. Format is HTML. Generally speaking, the more lines of code in sNextValueFn, the more highly recommended it is to use this field.
Instrument-specific fields		
bExternal	boolean	If TRUE, indicates that the quantity is an external quantity (described later) in all scenarios. If bInstrument is FALSE, this field is ignored.
sBoundsViolFn	string	C code that checks to ensure that a new instrument value is "legal" for the domain model. If the new value is out of bounds, whether too high or too low, the simulation may not be executed until the value is modified.
nFunctionaries	integer	The number of automated agents that have been defined for this instrument.
FunctionaryFns	array of strings	The C code implementing the algorithm for each of the defined agents. Assumes the result in each will be placed in the predefined floating-point variable dQResult. Each array element corresponds to one agent, and the array size is always equal to nFunctionaries.
FunctionaryStrategies	array of strings	Provides a brief textual description of the value-setting strategy for each of the defined agents. Should observe a similar style and voice in this field for all agents. Note that, depending upon pedagogical considerations, additional information or additional fields could be defined for each agent. For example, if each agent should have an associated picture, a field could be added for picture filenames.
InitDefaultFaryIndex	integer	Indicates which of the automated agents will be in effect initially when the scenario begins. If the quantity is an external, the indicated agent will control the value selection throughout the entire scenario.

FIG. 12B

Field Name	Outcome Quantity Example
sName	"Unemployment Rate"
bInstrument	FALSE
sDefinition	"The Unemployment Rate is the percentage of the workforce that does not have gainful employment at a point in time. The workforce only includes persons who are willing and able to work. $$$typical begin### The unemployment rate can range from 2 percent to 30 percent. Higher rates are likely to lead to social breakdown. $$$typical end### $$$model Inflation and Unemployment###"
sUnit	0.01
dPlaceholder	5.0

sNewsFn	double dNatural = Value("Natural Unemployment Rate" , -1);
	double dExcess = dNewValue - dNatural;
	
	if ((dExcess > 2.0) && (dExcess < 8.0))
	{
	CString s; s.Format("$$$def Your advisor###: Unemployment rate of %.1f is worrisome", dNewValue);
	AddNews(sQName,
	s,
	10, // importance, scale 0-100 (default value is 1.0)
	2 // "can repeat after" (must wait 3 quarters before repeating)
	);
	}
	if (dExcess >= 8.0)
	{
	double dImportance = 50;
	AddNews(sQName,
	"$$$def National Times###: Citizens desperate for relief from severe unemployment problem",
	dImportance,
	0
	);
	}

LineColor	(24 24 24)

sNextValueFn	double dReal = Value("Real Output", -1);
	double dPotential = Value("Potential Output", -1);
	double dRatio = dReal / dPotential;
	double dNatural = Value("Natural Unemployment Rate", -1);
	double dLastUnem = Value("Unemployment Rate", -1);
	double dTarget;
	
	if (dRatio <= 1.0) // under capacity
	dTarget = dNatural + (100.0 * (1.0 - dRatio));
	else
	dTarget = dNatural * (1.0 / pow(dRatio, 10.0));
	
	dQResult = dLastUnem + (0.75 * (dTarget - dLastUnem));

sNextValueDescr	"Computed as a function of the difference between $$$qty Real Output### and $$$qty Potential Output###. Unemployment is high when actual real output is less than potential, and the unemployment rate is low when actual is higher than potential. Greater differences between the two cause larger effects on unemployment."
sExplainNVFn	"Changes in unemployment result when there is a mismatch between output and the capacity of..."

FIG. 13

Fi Id Name	Instrum nt Quantity Example
sName	"Defense Expenditures"
bInstrument	TRUE
sDefinition	"Defense Expenditures is the total amount spent for our military, including salaries, equipment, weaponry, and other expenses. $$$typical begin### Defense expenditures may be zero, or may soar above 10 percent of $$$def total output|total output### during wartime. $$$typical end###"
sUnit	$1 Billion
dPlaceholder	100

sNewsFn	double lastAmount = Value("Defense Expenditures", -1);
	double pctg = PercentChange(lastAmount, dNewValue);
	
	if (pctg > 10.0)
	{
	AddNews(sQName,
	"$$$def National Times###: $$$qty Defense Expenditures### increase dramatically ",
	LinearEffect(pctg, 5.0, 20.0, 10, 40),
	1);
	}

LineColor	(0 0 140)
bExternal	FALSE

sBoundsViolFn	if (dProposedNewValue < 0.0)
	{
	bTooLow = TRUE;
	dValueLimit = 0.0;
	sExplanation = "Defense Expenditures cannot be negative.";
	}
	else if (dProposedNewValue > Value("Current Output", -1))
	{
	bTooHigh = TRUE;
	dValueLimit = Value("Current Output", -1);
	sExplanation = "Defense Expenditures cannot possibly be greater than total output.";
	}

nFunctionaries	2

FunctionaryFns	*Automated Agent 1:*
	double dLowerLimit = Average("Current Output", -4, -1) * 0.02;
	dQResult = max(dLowerLimit, Value("Defense Expenditures", -1) * 0.98);
	
	Automated Agent 2:
	double dUpperLimit = Average("Current Output", -4, -1) * 0.10;
	
	double dGrowthFactor = (Value("Price Index", -1) / Value("Price Index", -2)) * (Value("Potential Output", -1) / Value("Potential Output", -2));
	
	dQResult = min(dUpperLimit, Value("Defense Expenditures", -1) * max(1.02, dGrowthFactor));

FunctionaryStrategies	*Automated Agent 1:* "We need to reduce our heavy spending on military expenditures so that we can focus our economy's resources more on the private sector. Advances in military technology have made it possible for us to do more with less." *Automated Agent 2:* "We need to build up our defense capabilities. It's an increasingly dangerous world out there, and our weapons systems are getting old."
InitDefaultFaryIndex	0

FIG. 14

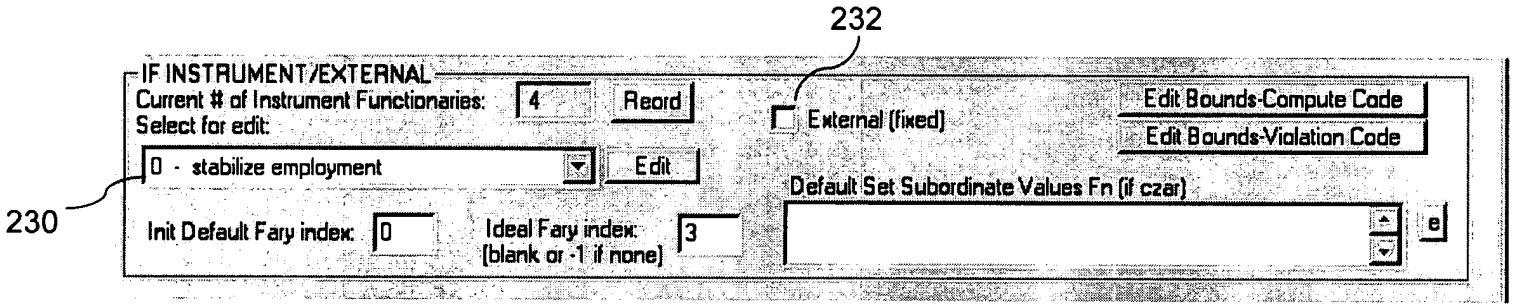

232
IF INSTRUMENT/EXTERNAL
Current # of Instrument Functionaries:
4
Reord
External (fixed)
Edit Bounds-Compute Code
Edit Bounds-Violation Code
Select for edit:
0 - stabilize employment
Edit
Default Set Subordinate Values Fn (if czar)
230
Init Default Fary index:
0
Ideal Fary index:
(blank or -1 if none)
3
e

FIG. 15

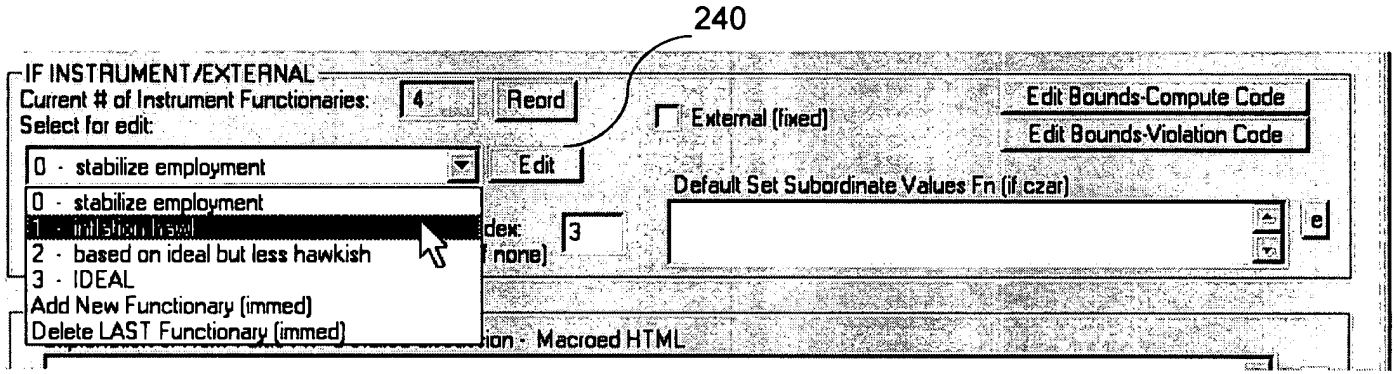

240
IF INSTRUMENT/EXTERNAL
Current # of Instrument Functionaries:
4
Reord
Select for edit:
0 - stabilize employment
Edit
External (fixed)
Edit Bounds-Compute Code
Edit Bounds-Violation Code
Default Set Subordinate Values Fn (if czar)
0 - stabilize employment
2 - based on ideal but less hawkish
3 - IDEAL
Add New Functionary (immed)
Delete LAST Functionary (immed)
3
e
Macroed HTML

FIG. 16

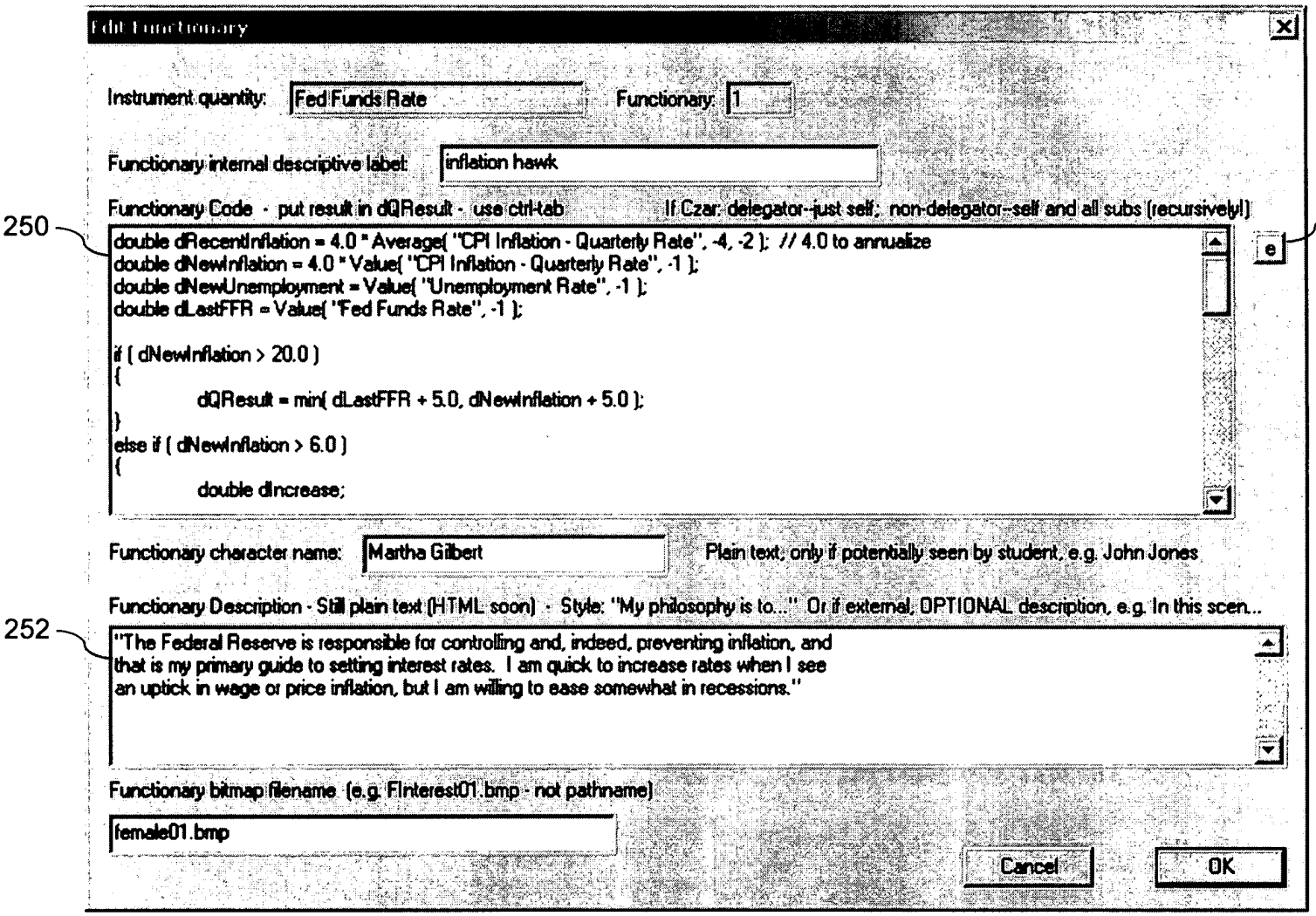

Edit Functionary
Instrument quantity:
Fed Funds Rate
Functionary:
1
Functionary internal descriptive label:
inflation hawk
Functionary Code - put result in dQResult - use ctrl-tab
If Czar: delegator--just self; non-delegator--self and all subs (recursively!)
250
251
e
double dRecentInflation = 4.0 * Average("CPI Inflation - Quarterly Rate", -4, -2); // 4.0 to annualize
double dNewInflation = 4.0 * Value("CPI Inflation - Quarterly Rate", -1);
double dNewUnemployment = Value("Unemployment Rate", -1);
double dLastFFR = Value("Fed Funds Rate", -1);
if (dNewInflation > 20.0)
{
dQResult = min(dLastFFR + 5.0, dNewInflation + 5.0);
}
else if (dNewInflation > 6.0)
{
double dIncrease;
Functionary character name:
Martha Gilbert
Plain text; only if potentially seen by student, e.g. John Jones
Functionary Description - Still plain text (HTML soon) - Style: "My philosophy is to..." Or if external, OPTIONAL description, e.g. In this scen...
252
"The Federal Reserve is responsible for controlling and, indeed, preventing inflation, and
that is my primary guide to setting interest rates. I am quick to increase rates when I see
an uptick in wage or price inflation, but I am willing to ease somewhat in recessions."
Functionary bitmap filename (e.g. FInterest01.bmp - not pathname)
female01.bmp
Cancel
OK

FIG. 17

"Macfarlane Tax Cuts" - Scenario Introduction

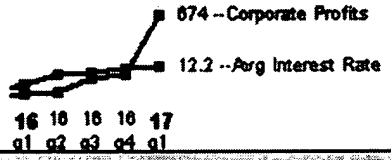
The Macfarlane Tax Cuts

It is the year 2017, and the public and politicians alike are alarmed at the recent surge in unemployment. Unemployment has been low for the past decade, but it has recently shot up above 9 percent.

The Democrats are loudly denouncing the president almost every day. Republican Carl Macfarlane won the 2016 election on a tax-reduction campaign platform, and, once elected, he immediately pushed dramatic tax decreases into place. In the first year, the **General Tax Rate** has dropped from 26 percent of Current Output down to 18 percent; individual tax rates dropped significantly, and the Corporate Tax Rate has dropped from 40 percent down to about 20 percent.

To attack the unemployment problem, Congress is putting together a "stimulus" program which will significantly increase discretionary spending during the next two years. They argue that the increased spending will create jobs and stimulate investment.

Many economists, however, point to the chronically high rates of inflation that the country has been experiencing, and they warn that adding new spending on top of Macfarlane's dramatic tax cuts will "overstimulate" the economy and trigger even worse inflation. They suggest that the effects of the tax cut will only occur with a lag, and that the recent unemployment is likely to reverse itself any day now.



Meanwhile, the corporate tax cuts are already having big, positive effects on the level of **Corporate Profits**. Recent earnings reports from corporations have been spectacular, and stock prices are rising. Some business leaders

OK

FIG. 18

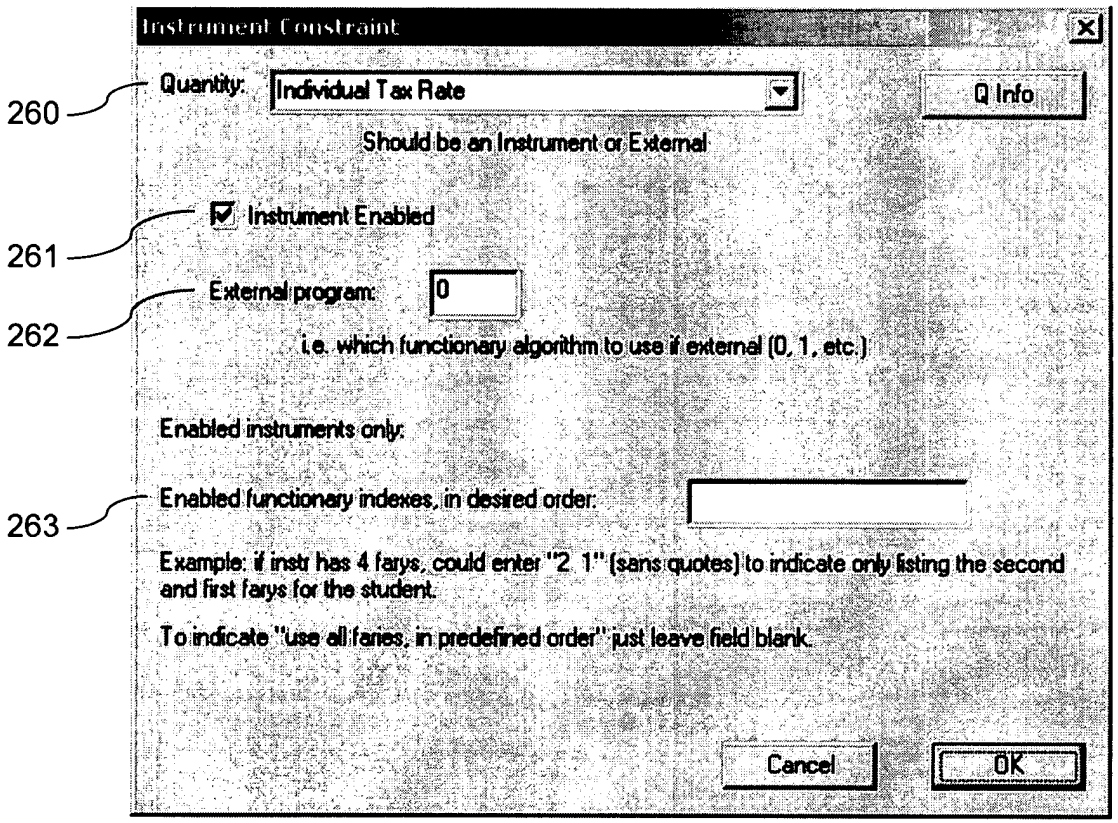

Instrument Constraint
Quantity:
Individual Tax Rate
Q Info
Should be an Instrument or External
Instrument Enabled
External program:
0
i.e. which functionary algorithm to use if external (0, 1, etc.)
Enabled instruments only:
Enabled functionary indexes, in desired order:
Example: if instr has 4 farys, could enter "2 1" (sans quotes) to indicate only listing the second and first farys for the student.
To indicate "use all faries, in predefined order" just leave field blank.
Cancel
OK
260
261
262
263

FIG. 19

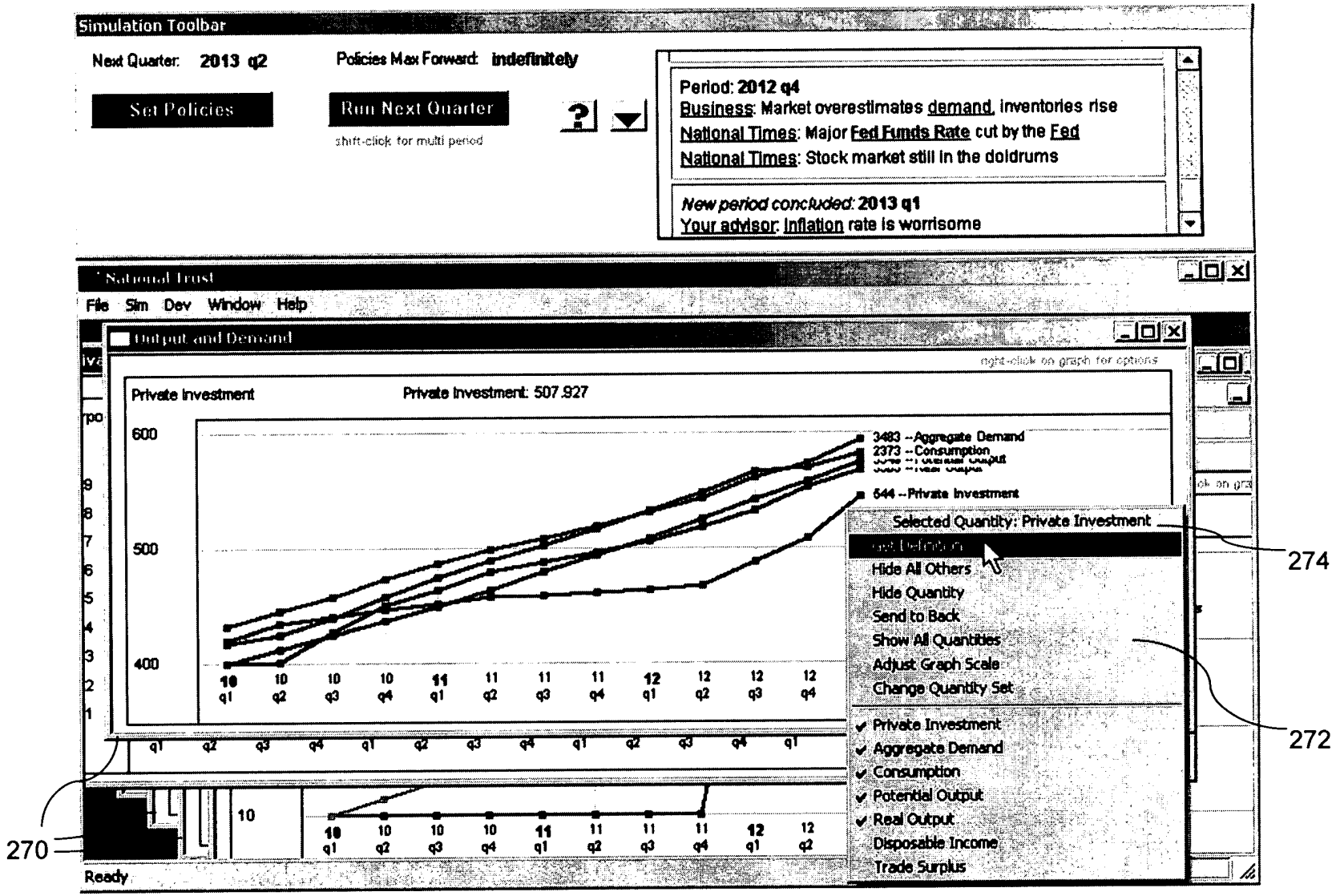

Simulation Toolbar
Next Quarter: 2013 q2
Policies Max Forward: indefinitely
Set Policies
Run Next Quarter
shift-click for multi period
Period: 2012 q4
Business: Market overestimates demand, inventories rise
National Times: Major Fed Funds Rate cut by the Fed
National Times: Stock market still in the doldrums
New period concluded: 2013 q1
Your advisor: Inflation rate is worrisome
National Trust
File Sim Dev Window Help
Output and Demand
right-click on graph for options
Private Investment
Private Investment: 507.927
600
500
400
3483 --Aggregate Demand
2373 --Consumption
644 --Private Investment
Selected Quantity: Private Investment
Hide All Others
Hide Quantity
Send to Back
Show All Quantities
Adjust Graph Scale
Change Quantity Set
Private Investment
Aggregate Demand
Consumption
Potential Output
Real Output
Disposable Income
Trade Surplus
Ready
270
272
274

FIG. 20

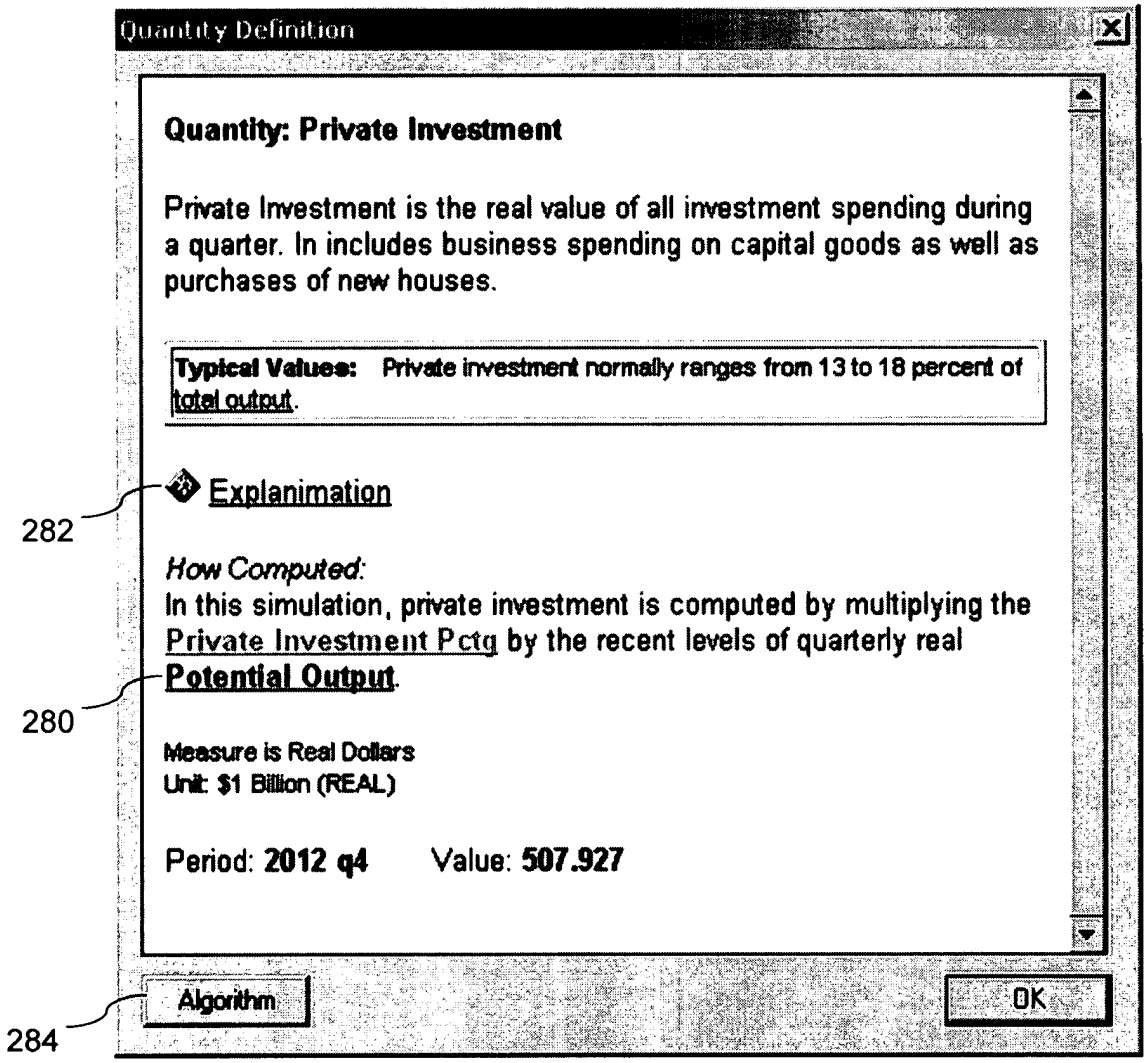

Quantity Definition
Quantity: Private Investment
Private Investment is the real value of all investment spending during a quarter. In includes business spending on capital goods as well as purchases of new houses.
Typical Values: Private investment normally ranges from 13 to 18 percent of total output.
Explanimation
282
How Computed:
In this simulation, private investment is computed by multiplying the Private Investment Pctg by the recent levels of quarterly real Potential Output.
280
Measure is Real Dollars
Unit: $1 Billion (REAL)
Period: 2012 q4 Value: 507.927
Algorithm
284
OK

FIG. 21

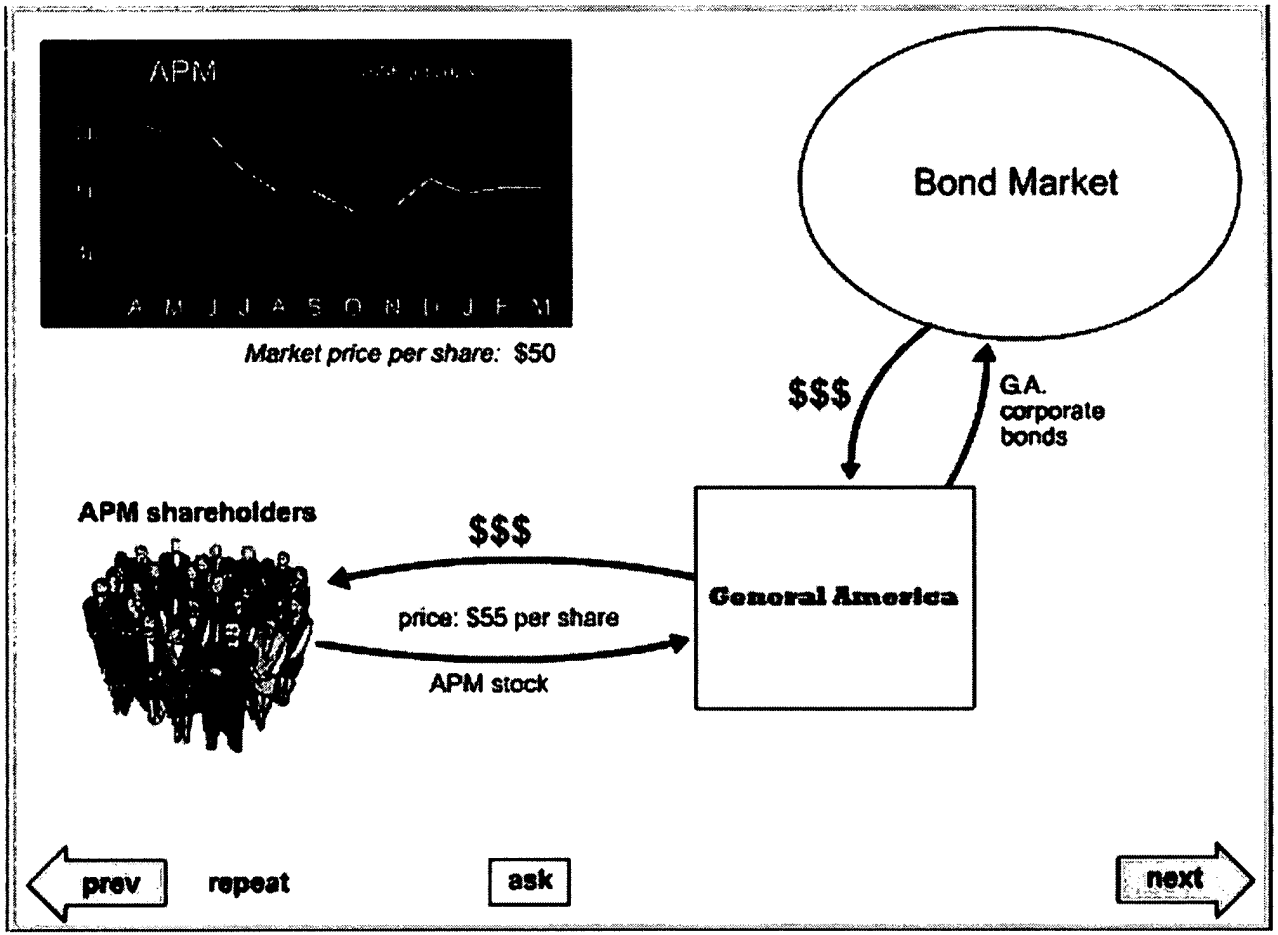

APM
Market price per share: $50
Bond Market
$$$
G.A. corporate bonds
APM shareholders
$$$
General America
price: $55 per share
APM stock
prev
repeat
ask
next

FIG. 22

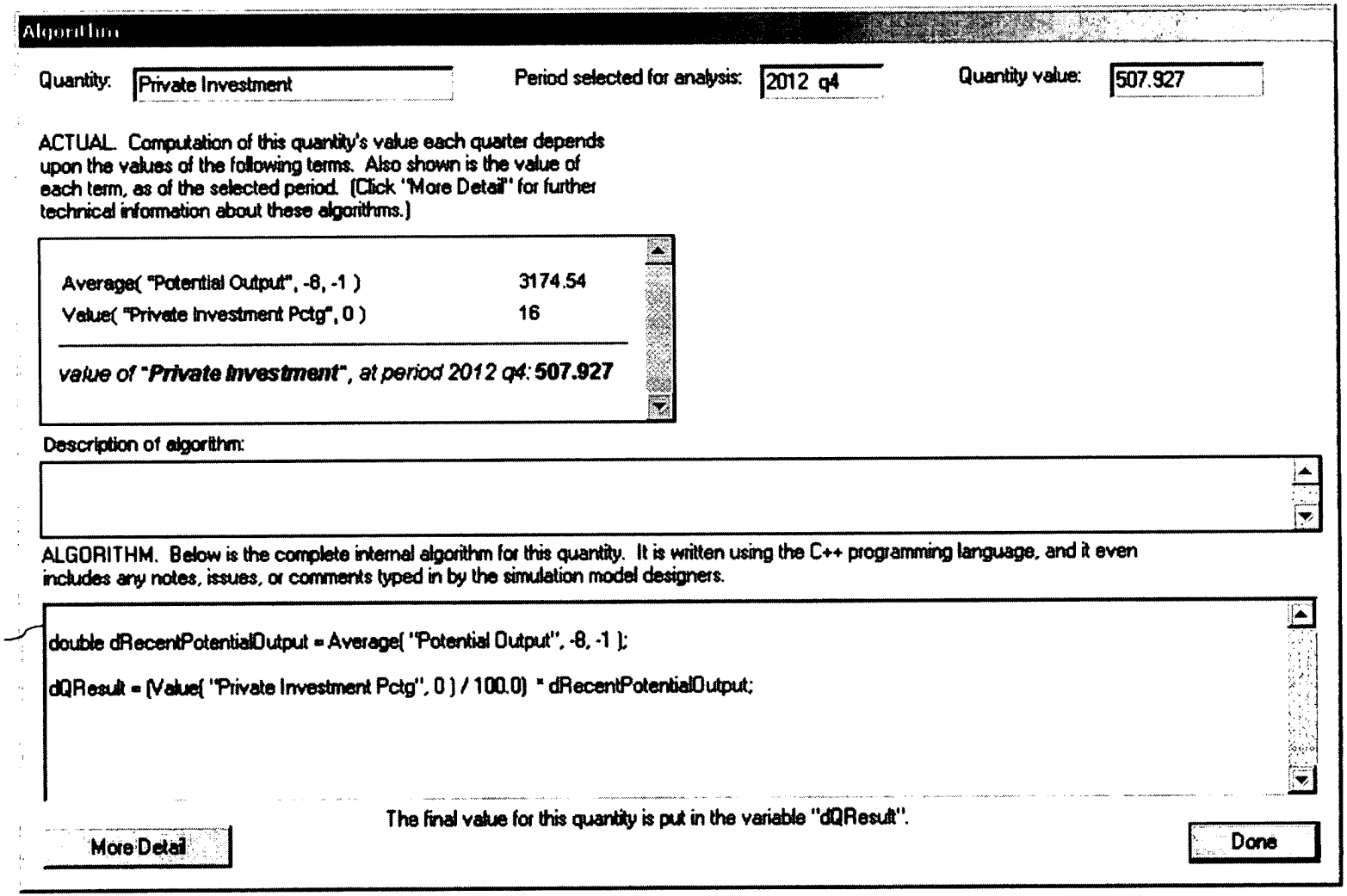

Algorithm
Quantity: Private Investment
Period selected for analysis: 2012 q4
Quantity value: 507.927
ACTUAL. Computation of this quantity's value each quarter depends upon the values of the following terms. Also shown is the value of each term, as of the selected period. (Click "More Detail" for further technical information about these algorithms.)
Average("Potential Output", -8, -1) 3174.54
Value("Private Investment Pctg", 0) 16
value of "Private Investment", at period 2012 q4: 507.927
Description of algorithm:
ALGORITHM. Below is the complete internal algorithm for this quantity. It is written using the C++ programming language, and it even includes any notes, issues, or comments typed in by the simulation model designers.
290
double dRecentPotentialOutput = Average("Potential Output", -8, -1);
dQResult = (Value("Private Investment Pctg", 0) / 100.0) * dRecentPotentialOutput;
The final value for this quantity is put in the variable "dQResult".
More Detail
Done

FIG. 23

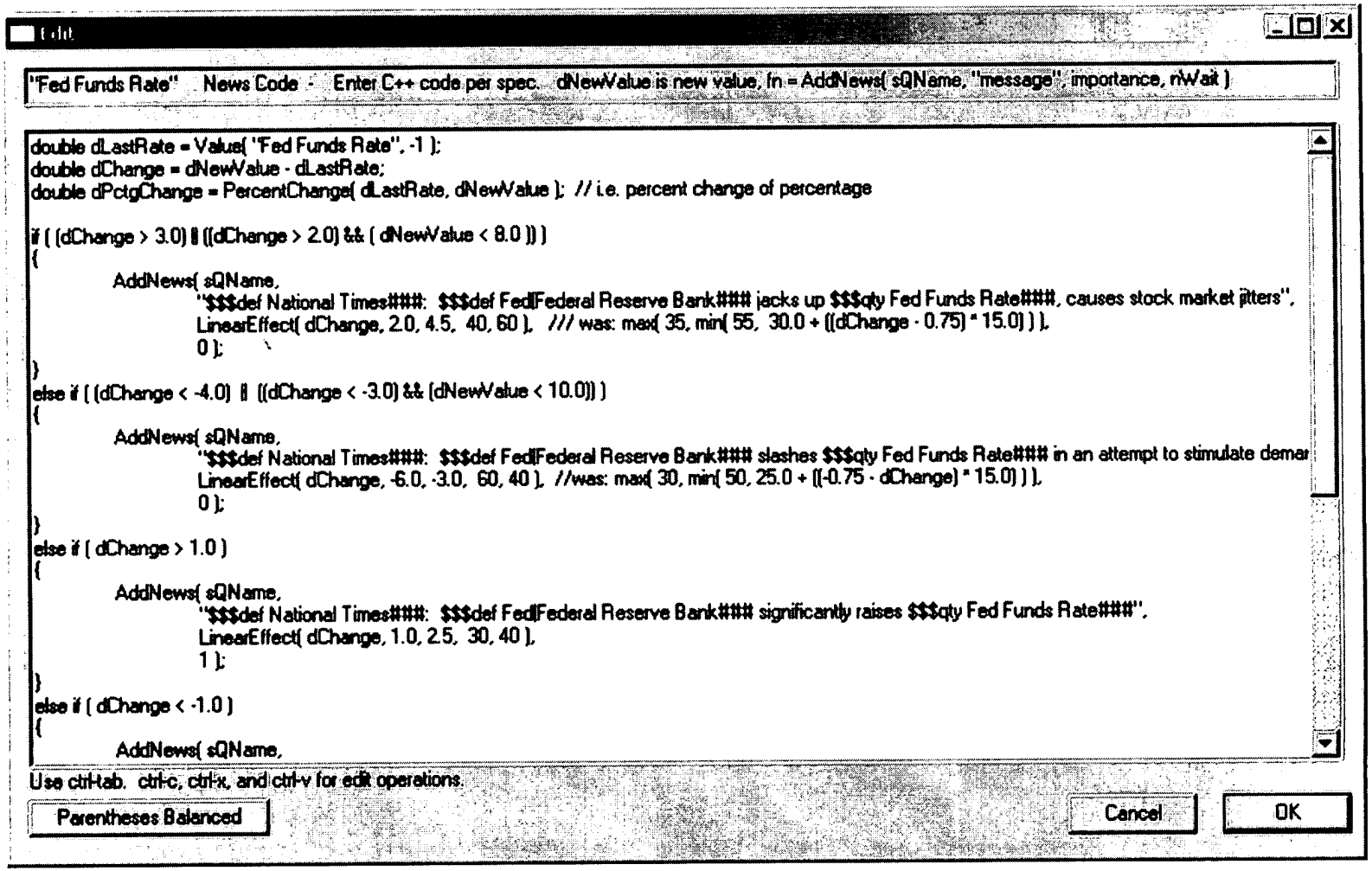

Edit
"Fed Funds Rate" News Code - Enter C++ code per spec. dNewValue is new value, fn = AddNews(sQName, "message", importance, nWait)
double dLastRate = Value("Fed Funds Rate", -1);
double dChange = dNewValue - dLastRate;
double dPctgChange = PercentChange(dLastRate, dNewValue); // i.e. percent change of percentage
if ((dChange > 3.0) || ((dChange > 2.0) && (dNewValue < 8.0)))
{
AddNews(sQName,
"$$$def National Times###: $$$def Fed|Federal Reserve Bank#### jacks up $$$qty Fed Funds Rate####, causes stock market jitters",
LinearEffect(dChange, 2.0, 4.5, 40, 60), /// was: max(35, min(55, 30.0 + ((dChange - 0.75) * 15.0))),
0);
}
else if ((dChange < -4.0) || ((dChange < -3.0) && (dNewValue < 10.0)))
{
AddNews(sQName,
"$$$def National Times###: $$$def Fed|Federal Reserve Bank#### slashes $$$qty Fed Funds Rate#### in an attempt to stimulate demar
LinearEffect(dChange, -6.0, -3.0, 60, 40), //was: max(30, min(50, 25.0 + ((-0.75 - dChange) * 15.0))),
0);
}
else if (dChange > 1.0)
{
AddNews(sQName,
"$$$def National Times###: $$$def Fed|Federal Reserve Bank#### significantly raises $$$qty Fed Funds Rate###",
LinearEffect(dChange, 1.0, 2.5, 30, 40),
1);
}
else if (dChange < -1.0)
{
AddNews(sQName,
Use ctrl-tab, ctrl-c, ctrl-x, and ctrl-v for edit operations.
Parentheses Balanced
Cancel
OK

FIG. 24

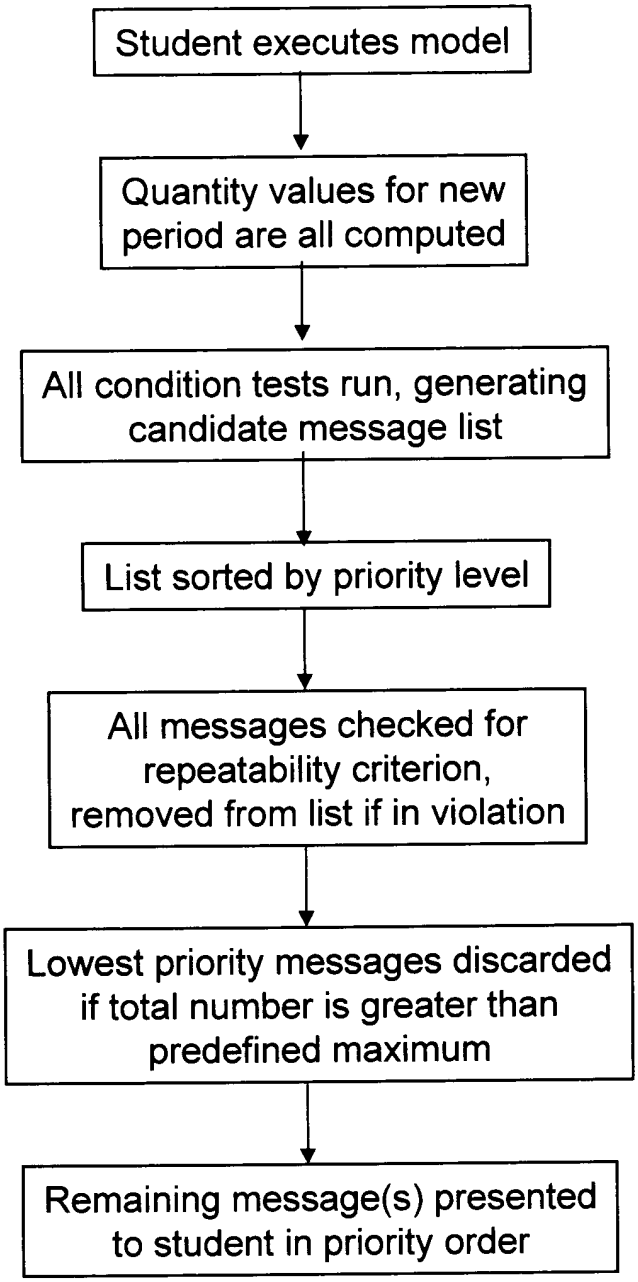

Student executes model
Quantity values for new period are all computed
All condition tests run, generating candidate message list
List sorted by priority level
All messages checked for repeatability criterion, removed from list if in violation
Lowest priority messages discarded if total number is greater than predefined maximum
Remaining message(s) presented to student in priority order

FIG. 25